# On some Zoantheæ from Queensland and the New Hebrides.

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(Plates 43–45.)

[Read 6th May, 1909.]

The Actinaria treated of in this paper form part of a small collection of these animals brought from Australia by Professor J. P. Hill, who kindly suggested the investigation to me, and to whom for his advice and assistance throughout the work my grateful thanks are due.

In the present communication the following four species are described as new :—

Zoantheæ.
Brachycneminæ.
*Zoanthus sandvicensis*, sp. n.
*Zoanthus similis*, sp. n.
*Zoanthus pigmentatus*, sp. n.
*Gemmaria arenacea*, sp. n.

Zoanthus sandvicensis, sp. n. (Pls. 43, 44. figs. 1–6.)

*Form* (Pl. 43. fig. 1).—The polyps form a colony covering an irregular shaped piece of coral and have apparently been broken off from a larger mass. The cœnenchyme is freely developed, and forms an incrustation over the coral, the indentations of which it closely follows. The free ends of the cœnenchyme advance in broad bands and form an almost continuous incrustation. Irregular spaces occur in the older parts, so that the whole structure forms a network.

The polyps grow fairly thickly on the cœnenchyme and are regularly distributed over its surface. In form they are usually cylindrical, but several of the larger are clavate. The capitula of the adults are all at nearly the same level. Their form and height seem to be determined by their position in the colony, since it is the polyps growing on the depressed borders of the coral which become drawn out and clavate; those on an elevated part are mere buttons having greater width than height. The columns in spirit specimens are wrinkled transversely. Three young polyps present on the older parts of the cœnenchyme arise from it directly, and not from the bases of other polyps.

*Colour*.—In spirit they are a light sand-colour. An enclosed label states that in life they were pink or green when expanded, and brown when contracted.

*Dimensions.*—Height 3–12 mm.; average height 6 mm.; diameter 3–5 mm.

*Locality.*—Collected in Erikor Lagoon, Sandwich Island, New Hebrides, by Mr. W. T. Quaife, in April 1903. 24 specimens.

The specific name *sandvicensis* refers to the island in the New Hebrides in whose waters they were collected.

*Column-wall* (Pl. 44. fig. 2).—A cuticle and subcuticle are present. Numerous foreign bodies, mainly diatoms, adhere to the cuticle. The ectoderm is discontinuous, and the connecting strands of mesoglœa pass at frequent and regular intervals from the mesoglœa to the subcuticle. Nucleated ectodermal cells are present more or less abundantly in some of the cavities thus formed; in others they are not to be distinguished. It is probable that shrinkage has taken place as large vacuoles are of frequent occurrence. Large oval nematocysts are present. The mesoglœa is thick, averaging 0·29 mm. The numerous canals and small sinuses present are not definitely enough arranged to give the appearance of a broken encircling canal. The lacunæ contain nucleated cells and nematocysts. Enclosed cells, both with and without fibrillate terminations, are very numerous, especially towards the base of the polyp. The endoderm, which is thick, contains occasional nematocysts and is crowded with zooxanthellæ in the region of the capitulum, though elsewhere they are rare. Comparatively few fibres run from the endoderm into the mesoglœa. A distinct endodermal muscle is to be seen in longitudinal sections.

*Capitulum.*—The capitulum is thrown into some 20–24 ridges. Its ectoderm is crowded with nematocysts, and its endoderm with zooxanthellæ.

*Sphincter muscle* (Pl. 44. fig. 3).—The sphincter muscle is double and embedded in the mesoglœa. In contraction, the line of demarcation between the two halves is very deep. The distal muscle is short but well developed. Its cavities are two rows deep distally, and the muscle ends abruptly at this point. The proximal muscle is very strong. At its widest part it occupies almost the whole of the mesoglœa, but lies throughout its course nearer the ectoderm than the endoderm. In parts indeed it is only separated from the ectoderm by the thinnest strands of mesoglœa. The cavities are very long at its widest point, and so closely packed together that the mesoglœa between them amounts merely to separating walls (Pl. 44. fig. 3). The cavities are lined with muscle-cells, and the smaller cavities have in addition a few free cells enclosed. The ectoderm in this region is crowded with nematocysts.

*Tentacles* (Pl. 44. fig. 4).—In three specimens cut transversely the tentacles number respectively 36, 39, and 40. The ectoderm is thick and contains two varieties of nematocysts: (*a*) Large oval, deeply staining nematocysts with distinct threads are crowded together in patches on the outer side of the tentacles (Pl. 44. fig. 4, *nem. a*); (*b*) Smaller narrow, unstained nematocysts, often slightly curved, are numerous in the apical region of the tentacles,

where they occur singly near the surface of the ectoderm (Pl. 44. fig. 4, *nem. b*). A well developed ectodermal muscle on small mesoglœal plaitings is present. Between the ectodermal nuclei and this muscle is a clear nervous zone containing numerous nerve-cells scattered irregularly, and a great number of small oval highly refractive bodies which do not stain. These bodies are most abundant in the tentacles especially towards the tips (Pl. 44. fig. 4, *r.b.*), but are also present in the disc. Von Heider (7) describes similar structures in the disc of *Z. chierchiæ*. The mesoglœa is thin, and contains lacunæ and occasional enclosed cells (Pl. 44. fig. 4, *m.*). The endodermal muscle is small and flat (Pl. 44. fig. 4, *end.m.*). The endoderm is much thicker than the ectoderm, and so crowded with zooxanthellæ that the endodermal nuclei are generally only visible at the edge of the lumen, which itself is very small.

*Disc* (Pl. 44. fig. 5).—The ectoderm of the disc is broad and its structure unusual. Internal to the nuclei of the columnar cells there is a granular nucleated zone of considerable breadth. In the centre of the disc this zone is divided by a clear space crossed by fibres, which does not exist in the peripheral part of the disc. This granular ectoderm frequently invades the mesoglœa and reaches the endoderm. The layer of mesoglœa therefore is apparently not continuous through the disc, and where present is broken into pieces of various shape (Pl. 44. fig. 5, *m.*). An endodermal muscle is seen only where mesoglœa is also present. This granulated ectoderm is present through the whole disc, and is at its thickest at the commencement of the lip. It disappears as the lip turns over into the œsophagus. Von Heider describes "eine eigenthümliche Gewebeschicht" in the disc of *Z. chierchiæ* (7), which is very similar to this structure, but which does not invade the mesoglœa, and is also apparently quite distinct from the overlying ectoderm. In the endoderm, which is half the width of the ectoderm, the zooxanthellæ present are not sufficiently numerous to conceal the endoderm cells. The lip is raised.

*Œsophagus*.—The ectoderm of the œsophagus consists of three zones as described in *Z. flos marinus*, McMurrich & Duerden (3 and 8), and in *Z. chierchiæ*, von Heider (7). Nematocysts are very numerous, and gland-cells much more so than figured by von Heider (7). A sulcar groove is present, and the ectoderm which lines it is thinner and smoother than elsewhere. The folding of the ectoderm is very irregular.

*Mesenteries* (Pl. 44. fig. 6).—The mesenteries in three specimens cut numbered 36, 38, and 40. Owing to great increase in numbers of zooxanthellæ in the endoderm near the œsophagus, the mesenteries are much thicker there than towards the column-wall. Nematocysts are also present. The mesoglœa is thick, reaching its maximum in the directive mesenteries. The longitudinal muscle is strongly developed on long plaitings of the mesoglœa (Pl. 44. fig. 6, *l.m.*). The parieto-basilar muscle is well developed on both

sides; on the entocœle side it is continuous with the longitudinal muscle; on the exocœle side it continues to about two-thirds the length of the basal canal. A large basal canal is present, oval or circular in transverse sections (Pl. 44. fig. 6, *b. c.*). In the upper part of the polyp, the basal canal widens into a long slit which may be continuous through the width of the mesentery. Duerden (8) has described the opposite condition in *Z. pulchellus*, where the long slits occur at the base of the polyp. The endoderm of the mesenteries from the capitulum to the lower end of the œsophagus contains very numerous zooxanthellæ. Below that point there are none present. As zooxanthellæ disappear from the endoderm of the column-wall at about the same level, it follows that they are very abundant in the distal and rare in the proximal part of the polyp. The reflected ectoderm of the mesenteries closely resembles that of *Z. Macgillivrayi* as described by Haddon and Shackleton (5). The digestive endoderm is very thick and encloses many foreign granules as in *Z. flos marinus* (3 and 8); but here nematocysts also occur, while the green granules of *Z. flos marinus* are rare.

*Gonads.*—The species is hermaphrodite. Spermaria are present in abundance in all five polyps examined. Three ova also occur in one polyp and a single ovum in another. All four ova are ripe, of large size, and borne on mesenteries which carry spermaria also. Nematocysts are frequently present in the endoderm surrounding the spermaria.

*Parasites.*—Two kinds of parasitic Protozoa are present in large numbers in the swollen endoderm of the mesenteries.

The unusually powerful sphincter muscle of *Z. sandvicensis* is its distinguishing characteristic.

This is the more remarkable, since, as pointed out by Duerden (8), the sphincter muscle in Pacific species is, on the whole, much less developed than in West Indian species.

In other anatomical points *Z. sandvicensis* comes nearest to *Z. flos marinus* described by Duerden from the West Indies, and to *Z. chierchiæ*, von Heider (7). The locality of the latter is unknown.

It is, however, easily distinguished from these two species by, among other points, the sphincter muscle, number and character of mesenteries, structure of column-wall and ectoderm, and form of cœnenchyme.

Zoanthus similis, sp. n. (Pls. 43, 44. figs. 7–10.)

*Form* (Pl. 43. fig. 7).—This colony closely resembles that of *Z. sandvicensis* in external appearance, but the polyps are distinctly smaller and more slender. The growth of the cœnenchyme takes place as in *Z. sandvicensis* by broad bands. Several are present measuring 12–15 mm. in length, and 5–7 mm. in width. There is a large growth of cœnenchyme at one side (Pl. 43. fig. 7), on which some young polyps are developing at long intervals.

*Colour.*—Sand-colour in spirit. No account of colour when living enclosed.

*Dimensions.*—Height 2–8 mm., average 2–5 mm.; diameter of capitulum 2–3·5 mm.

*Locality.*—Collected in Erikor Lagoon, Sandwich Island, New Hebrides, by Mr. Douglas Mawson, B.E., B.Sc., in 1903. Part of a colony. Numerous specimens.

The specific name refers to its undoubted relationship to *Z. sandvicensis*.

*Column-wall.*—Distinctly thinner than in *Z. sandvicensis*, averaging ·19 mm. in place of ·29 mm. (Pl. 44. fig. 8). The ectoderm is discontinuous; a cuticle and subcuticle are present. The cavities in the mesoglœa in which the ectoderm lies are more irregular than those of *Z. sandvicensis* and contain a larger amount of cellular tissue, indeed the latter may occasionally fill the mesoglœal spaces. In this smaller species endodermal fibres extending through the mesoglœa are more numerous than in *Z. sandvicensis*, but the general structure of the column-wall is very similar in the two species.

*Sphincter muscle* (Pl. 44. fig. 9).—This is double and strong, consisting of small rounded and irregular cavities which extend through the greater width of the mesoglœa. The muscle-lining is thin and free muscle-cells are present in all the cavities. Large quantities of diatoms are caught in the ridges of the capitulum in this region.

*Tentacles.*—Number 50, 54, and 56 in three specimens examined. The ectoderm and mesoglœa resemble those of *Z. sandvicensis*; large oval, and small narrow, nematocysts are present, but the oval refractive bodies of *Z. sandvicensis* are absent. The endoderm contains fewer zooxanthellæ and the lumen is larger.

*Disc.*—The structure of the ectoderm and mesoglœa resembles that of the tentacles, but the endoderm is much narrower and contains fewer zooxanthellæ. Only the large oval nematocysts are present in the ectoderm, which is not granulated as in the last species.

*Œsophagus* (Pl. 44. fig. 10).—The structure of the œsophagus resembles that of *Z. sandvicensis*, *Z. flos marinus*, and *Z. chierchiæ* (3, 6, and 8). The folding of the œsophagus is always unsymmetrical. Nematocysts are very numerous in the ectoderm.

*Mesenteries* (Pl. 44. fig. 10).—The mesenteries number 50–56. In this species all the perfect mesenteries including the sulcar directives are of equal thickness and the basal canal is oval. The musculature is well developed, the longitudinal retractor muscles on plaitings of the mesoglœa. Nematocysts are present in the endoderm and zooxanthellæ are very abundant, but, as in *Z. sandvicensis*, these latter are absent below the level of the œsophagus.

*Gonads.*—All the six polyps cut were fertile, and the gonads well developed, ripe and numerous. Three were male individuals, and three female. This is the first instance recorded of both male and female individuals being present in one colony of *Zoanthus*. Haddon and Shackleton mention that they did not

meet with an instance in any Zoantheæ (5). Our knowledge of the reproductive systems of the genus *Zoanthus* is, however, still incomplete, since several species have been described which contained no gonads.

*Z. sandvicensis* and *Z. similis* are undoubtedly closely allied. The two species resemble each other externally in general appearance and in the character of the cœnenchyme ; and internally, in the general structure of the column-wall, mesenteries and tentacles. They differ in shape and size and in several anatomical points, such as structure of the disc, thickness of the column-wall, character of the sphincter muscle, and number of mesenteries and tentacles. These latter number from 50–56 in the smaller form, *Z. similis*, and from 34–40 in *Z. sandvicensis*.

The sphincter muscle of *Z. similis* is intermediate in structure between that of *Z. sandvicensis* and of *Z. chierchiæ*, von Heider (6). It differs from the former in arrangement, shape and number of cavities and their contents (Pl. 44. figs. 3, 9), and from the latter in that it does not lie nearer the endoderm, but occupies the whole width of the mesogloea and the cavities, which are much more numerous and more closely packed than in *Z. chierchiæ* ; all contain free muscle-cells.

I have had some difficulty in deciding whether the two forms *Z. sandvicensis* and *Z. similis* should be regarded as one or two species, and have decided on the latter alternative chiefly from a consideration of the value placed on the sphincter muscle for specific purposes within the genus. The other anatomical differences give weight to this decision.

ZOANTHUS PIGMENTATUS, sp. n. (Pls. 43, 45. figs. 11–15.)

*Form* (Pl. 43. fig. 11).—The polyps, which are distinctly club-shaped, present a very irregular appearance both in size and grouping. Column and capitulum alike are much wrinkled transversely, only a few fine ridges are present at the opening in the swollen capitulum. The cœnenchyme forms a flattened expansion, from which little groups of polyps arise. This may have formed a network, but the pieces collected are not sufficient to decide the point. Stolons are also present, and occasionally a stolon is found passing from one polyp to another above the level of the cœnenchyme proper. New polyps arise either directly from the new unpigmented cœnenchyme, or by budding from the column of an older individual. In this latter case, the budding takes place near, but not at, the base of the column, and the piece of the column below the budding forms a common stalk for both polyps (Pl. 43. fig. 11). In this way are formed the stems with two branches which arise here and there from the cœnenchyme.

*Colour.*—Greyish brown in spirit : a few of the polyps and patches of the cœnenchyme are a light sand-colour. Reddish-brown spots surround the orifice of the capitulum in many individuals.

*Dimensions.*—Height 5–24 mm., average 8–10 mm. ; diameter, capitulum 3–4 mm., column 1·5–2 mm.

*Locality.*—Collected at Masthead Island, Queensland, by Mr. C. Hedley's expedition in 1904.

The specific name *pigmentatus* refers to the circular zone of pigment-granules in the mesoglœa of the column-wall.

*Column-wall.*—Beneath the cuticle of many of the shorter polyps one or two little grains of coral are to be seen. In many of the longer ones this process has gone much further, and the basal half of the polyp is covered with little projections each containing a number of coral fragments. Sections show that a very irregular form of incrustation has taken place. The coral fragments are not distributed regularly round the column-wall, they remain closely packed together and occupy the whole width of the mesoglœa immediately interior to their point of entry. In many cases single pieces break through the endoderm and enter the cœlenteron. These coral fragments are sometimes sufficiently numerous to make the polyp quite rigid, and occurring as they do in the slender basal part of the elongated polyps must afford a great support. Seven polyps of different heights were sectionized, and in each case small fragments of coral were found lying free in the cœlenteron.

The column-wall is comparatively thin, averaging ·15 mm. The proximal part is thicker than the distal. A yellow cuticle and a very thick subcuticle are present. In longitudinal sections the column-wall frequently presents a correspondingly convoluted appearance to that of *Z. Shackletoni* (Haddon & Duerden, 7). But in this species the ectoderm and mesoglœa proper take part in the folding. Fig. 12 is a drawing of a much less wrinkled specimen. The ectoderm is discontinuous, but the connecting strands of mesoglœa are neither so numerous nor so regular as in *Z. sandvicensis* (fig. 12). A large number of nucleated ectodermal cells are present in irregular groups, and the ectodermal spaces contain also many large oval nematocysts. The mesoglœa is thinner in the distal part of the column and capitulum than in the proximal part.

An irregular row of globular lacunæ lies in the mesoglœa immediately below the ectoderm (Pl. **45.** figs. 12, 13), extending throughout the length of the column and into the proximal portion of the capitulum. Generally these globular lacunæ appear quite empty, but they may contain a little pigment and more rarely a single nucleated cell. Duerden has described the same structures, but without contents, as occurring in *Z. Solanderi* (8).

In close proximity to these spherical cavities and scattered partly among them is a very distinct circular zone of pigment-granules. Its presence gives a characteristic appearance to transverse sections of this species (Pl. **45.** figs. 12, 15). This zone is present throughout the length of the column, and

the pigment-granules increase in the region of the capitulum. Proximally they become scattered through the mesoglœa.

Abundant lacunæ containing nematocysts and cellular tissue form a broken encircling canal situated about the middle of the mesoglœa. Ectodermal canals entering the mesoglœa are frequent (Pl. 45. fig. 15, *ect.c.*). A weak endodermal muscle is present. The zooxanthellæ are many rows deep in the endoderm distally, proximally they are rarer.

In the basal contracted part or pedicel of the polyp the cœlenteron is represented by a series of small cœlenteric canals branching in a mesogloeal mass, which is continuous with the column-wall and which contains many lacunæ. The structure of the pedicel is, therefore, precisely that of a stolon. In elongated polyps this portion is very long, at least a quarter of the total length of the polyp.

*Capitulum.*—The capitulum is thrown into a few fine ridges. A cuticle and subcuticle are present. The subcuticle is thinner, and nematocysts are more numerous than in the column-wall.

*Sphincter muscle* (Pl. 45. fig. 13).—The sphincter muscle is double and mesoglœal. The line of demarcation between the two portions is very deep. The proximal portion consists of a large number of small irregular cavities which are scattered throughout the width of the mesoglœa, internal to the globular lacunæ. All the cavities contain free muscle-cells of large size which frequently entirely fill the spaces. The distal muscle is small. Its cavities may be arranged in the characteristic horseshoe-shape, or more irregularly as in fig. 13.

*Tentacles.*—The tentacles in three cases number respectively 50, 50, and 52. Cuticle and subcuticle are absent. Small narrow unstained nematocysts are present in numbers in the outer border of the ectoderm, and fewer large oval ones are scattered through it. Yellow pigment-granules are more or less abundant in the ectoderm of many of the tentacles, while in others there are only a few granules. The mesoglœa is thin and contains cells. The ectodermal muscle is stronger than the endodermal, and is slightly plaited. The endoderm is so crowded with zooxanthellæ that no lumen is present.

*Disc.*—The structure of the disc resembles that of the tentacles, but the endoderm is thinner than the ectoderm. The latter contains patches of yellowish pigment.

*Œsophagus* (Pl. 45. fig. 15).—The ectoderm is not thrown into definite ridges, and is generally quite smooth.

Both nematocysts and yellow pigment are present in the non-staining nervous zone. The mesoglœa and endoderm are both thin. The latter contains zooxanthellæ.

*Mesenteries* (Pl. 45. figs. 14 and 15).—The mesenteries in three specimens cut number 50, 50, and 52. They are of the brachycnemic type and very thin towards the œsophagus. The basal canal is small oval in transverse

section, frequently contains nematocysts, and is double above the level of the mouth. The endoderm is narrow and contains numerous zooxanthellæ and nematocysts. Both parieto-basilar and longitudinal retractor muscles are well developed, the latter on plaitings of the mesoglœa (Pl. 45. fig. 14, *p.b.m.* & *l.m.*). The digestive endoderm present on the mesenteries in the proximal region is not so thick as in *Z. sandvicensis*. It contains many nematocysts, and is loaded with pigmented granules to such an extent that the whole endoderm is often of a bright yellow-brown colour left unstained by the carmine.

*Gonads.*—All the polyps cut are fertile and contain ova only.

*Parasites.*—A dark brown encysted parasite, probably protozoan, is present in numbers in some of the basal canals.

The abundance of yellow-brown pigment present in *Z. pigmentatus* is very striking. At the same time zooxanthellæ are as abundant as in *Z. sandvicensis* and *Z. similis*, in which species there is very little pigment. It seems, therefore, that the relationship between zooxanthellæ and pigment-granules, in virtue of which they replace one another in the genus *Parazoanthus* and in several families of Actinaria (Duerden, 9), does not exist in these species.

*Z. pigmentatus* resembles *Z. sociatus* (McMurrich, 4) in size, shape and colour, in its irregular mode of growth and in its stolon. Professor McMurrich, however, to whom I have submitted specimens, has no hesitation in describing it as distinct from his species. He also, with great kindness, sent specimens of *Z. sociatus* for comparison.

The globular cavities in the mesoglœa are present also in *Z. Solanderi* (8), but confusion between *Z. Solanderi* and *Z. pigmentatus* is impossible. *Z. pigmentatus* can be readily distinguished from all species hitherto described, by the pigment zone, the sphincter muscle, the structure of the column-wall, and by the irregular incrustation in the proximal half of many of the polyps, all other species of this genus having the mesoglœa proper of the column-wall unincrusted.

Gemmaria arenacea, sp. n. (Pls. 43, 45. figs. 16–20.)

*Form* (Pl. 43. fig. 16).—The polyps, erect, cylindrical, rigid and very gritty, arise from a freely developed, tough, and very thick cœnenchyme. They are of equal diameter throughout. The capitulum, marked by some 28 to 29 ridges, is not swollen in retraction. The young polyps present arise from the cœnenchyme, not from the bases of other polyps. The surface is thickly covered with adhering sand grains, which form a crust largely concealing the deep transverse wrinkles of spirit-specimens. Both column and cœnenchyme are overgrown with patches of *Rivularia* and *Lyngbya*, two genera of the Cyanophyceæ, from which the ridges of the capitulum are more or less free.

*Colour.*—Sand-coloured in spirit-specimens.

*Dimensions.*—Vary considerably in the different polyps, and are independent of position of polyp in the colony. Height 5–14 mm., average 8–10 mm.; diameter 4–7 mm., average 5–6 mm.

*Locality.*—Collected at Masthead Island, Queensland, by Mr. C. Hedley's expedition in 1904. Numerous specimens.

The specific name *arenacea* has reference to its markedly incrusted character. No species of this genus hitherto described is so thickly incrusted with calcareous sand-grains.

*Column-wall* (Pl. 45. figs. 17–18).—The incrustations of the column-wall are chiefly calcareous sand-grains with a sprinkling of siliceous spicules. A certain amount of selection is shown, the sand-grains in the distal part of the capitulum being more regular in size and much smaller than those in the column. Still smaller grains are found in the disc and tentacles. The occasional siliceous spicules are distributed irregularly throughout, and not confined to the lower column-wall as described by von Heider in *G. variabilis* (11). The incrustations extend through the whole of the ectoderm and occupy from one-half to four-fifths of the mesoglœa also. They penetrate to a varying and irregular depth in different parts of the same column-wall. Peripherally the sand-grains are so closely packed that only small portions of the original tissue are seen between them. More centrally they may be very scattered. Occasionally a grain comes into contact with the endoderm, and pushing it inwards forms a projection into the cœlenteron. In the capitulum the incrustations do not pass through the sphincter muscle.

The ectoderm is of the continuous type, and no cuticle is present. It is much broken up and its structure difficult to determine owing to numerous grains of sand imperfectly enveloped which project through the surface. Zooxanthellæ are everywhere very numerous. In the capitulum the ectoderm is much less broken, and the zooxanthellæ, massed together, occupy all the tissue free from sand-grains. In this region the ectoderm presents very irregular internal limitations as in *G. variabilis*, Duerden (8). It is here much thicker than in the column, reaching an average width of 2 mm. and in the ridges 3·5 mm. The mesoglœa measures about 2 mm. in the capitulum, and attains its greatest breadth (8 mm.) in the proximal part of the column. The innermost portion of the mesoglœa, which is free from incrustations, contains no sinuses, but many cell islets and lacunæ are scattered irregularly through its substance. They are filled with zooxanthellæ, and are much more numerous proximally. Single cells and long radial fibres stretching from the endoderm through the mesoglœa are very common, and the endodermal surface of the mesoglœa is much plaited. A considerable amount of pigment is present, chiefly confined to the cell islets and lacunæ. The endoderm is thin and contains zooxanthellæ,

but they are not so numerous as in the ectoderm, and this rule obtains throughout the polyp.

*Sphincter muscle* (Pl. 45. fig. 19).—The sphincter muscle is single, mesoglœal and relatively weak, and lies throughout its length close to the endoderm. In position it resembles the sphincter of *G. multa sulcata* (Carlgren, 13), but is distinctly weaker. It consists of an irregular single row of small mesoglœal cavities which are completely filled with muscle-cells. These cavities are extremely small proximally ; distally they increase in size.

*Tentacles.*—In two polyps the tentacles numbered 56. The ectoderm is several times thicker than either meso- or endoderm. Long, narrow nematocysts occur in small numbers in the outer zone of the ectoderm, while the inner zone is crowded with zooxanthellæ. Little groups of sand-grains lie in the ectoderm on the outer side only of the tentacles and towards their tips. A weak ectodermal muscle is present. The mesoglœa and endoderm are both thin. The former contains numerous isolated cells. Zooxanthellæ occur in the endoderm, but not in sufficient numbers to fill the lumen.

*Disc.*—The centre of the disc is smooth and flat. The mouth is oblong and placed on a slight prominence. Peripherally there are a number of ridges, produced by thickenings of the mesoglœa, one corresponding to each of the tentacles. In the centre of the disc both ectoderm and mesoglœa contain a thin sprinkling of minute sand-grains (Pl. 45. fig. 20, *lac.d.*). The ectoderm, which is very thick throughout and particularly so peripherally (Pl. 45. fig. 20), contains many zooxanthellæ. The mesoglœa is thickest at the central part of the disc. Numerous large isolated cells are enclosed in this layer, and enter the bases of the tentacles at their point of junction with the disc (Pl. 45. fig. 20, *ect.m.*). These appear to be identical with the ectodermal muscle-cells described by Hill and Whitelegge (12) as present in the disc of *G. Willeyi*. The endoderm is thin and contains few zooxanthellæ.

*Œsophagus* (Pl. 45. fig. 18).—The œsophagus has the usual well-marked truncated groove characteristic of the genus. Its ectoderm is deeply folded into 10 ridges, the mesoglœa passing partly into these. A good deal of pigment is present in the clear nervous zone. In the sulcar groove the ectoderm is smooth and thinner than elsewhere, while the mesoglœa is thicker. Its many cell enclosures are scattered irregularly and not placed at the insertion of the mesenteries as in *G. isolata*, *G. Rusei*, and *G. canariensis* (3, 4, & 6). The endoderm is low with occasional zooxanthellæ.

*Mesenteries.*—The arrangement of mesenteries is brachycnemic. In one polyp cut transversely, there are thirteen perfect mesenteries on one side and fifteen on the other (Pl. 45. fig. 18). In another there are fourteen perfect mesenteries on each side. The sulcar directives are always much thicker than the other mesenteries, but the degree of difference varies. The mesoglœa is thick and the endoderm thin, containing from one to two rows of

zooxanthellæ. The parieto-basilar and longitudinal muscles are very feebly developed, and the plaiting present is not well marked. In this it agrees with the other Australian forms, *G. Macmurrichi* and *G. mutuki*, Haddon & Shackleton (5). The basal canal through the greater part of its length is large and oval; distally it breaks up into 6–8 smaller canals. Proximally the basal canals elongate and widen considerably, the mesoglœa thickens and the mesenteries become joined together in the centre, forming a large mass pierced by the numerous basal canals and attached to the column-wall by the narrow ends of the thickened mesenteries. In this way the body-cavity is filled up a little distance above the base of the polyp. This mesenteric mass is in direct continuity with the mesoglœa of the cœnenchyme, and its basal canals are in communication with lacunæ in that structure. Duerden (8) describes a somewhat similar arrangement in *Isaurus Duchassaingi*. I have not been able to trace any connection between the basal canals and the spaces in the column-wall.

*Gonads.*—There were no gonads present in any specimen examined.

The distinguishing characters of *G. arenacea* are :—

(1) Its markedly incrusted character.

(2) Its weak sphincter muscle, the cavities of which are completely filled with muscle-cells.

[*G. isolata*, McMurrich (4), has a few of the upper cavities of the sphincter filled in the same manner.]

(3) Its shape. It is shorter and at the same time thicker than any other of the smaller species of *Gemmaria*. It agrees with *G. fusca*, Duerden (8), and disagrees with all others in having a column of equal diameter throughout, including the capitulum.

It is, perhaps, most closely allied to *G. canariensis* (Haddon & Duerden, 7), but in addition to the above general points of difference it has no cuticle, a different number of mesenteries, and distinctly weaker mesenteric musculature, in which latter point it agrees better with the Australian species *G. Macmurrichi* and *G. mutuki* (Haddon & Skackleton, 5).

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January 1909.

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## EXPLANATION OF THE PLATES.

### Plate 43.

Fig. 1. *Zoanthus sandvicensis*. Portion of a colony. × 3.
7. *Zoanthus similis*. Portion of a colony. × 3.
11. *Zoanthus pigmentatus*. Portion of a colony. × 3.
16. *Gemmaria arenacea*. Portion of a colony. × 3.

### Plate 44.

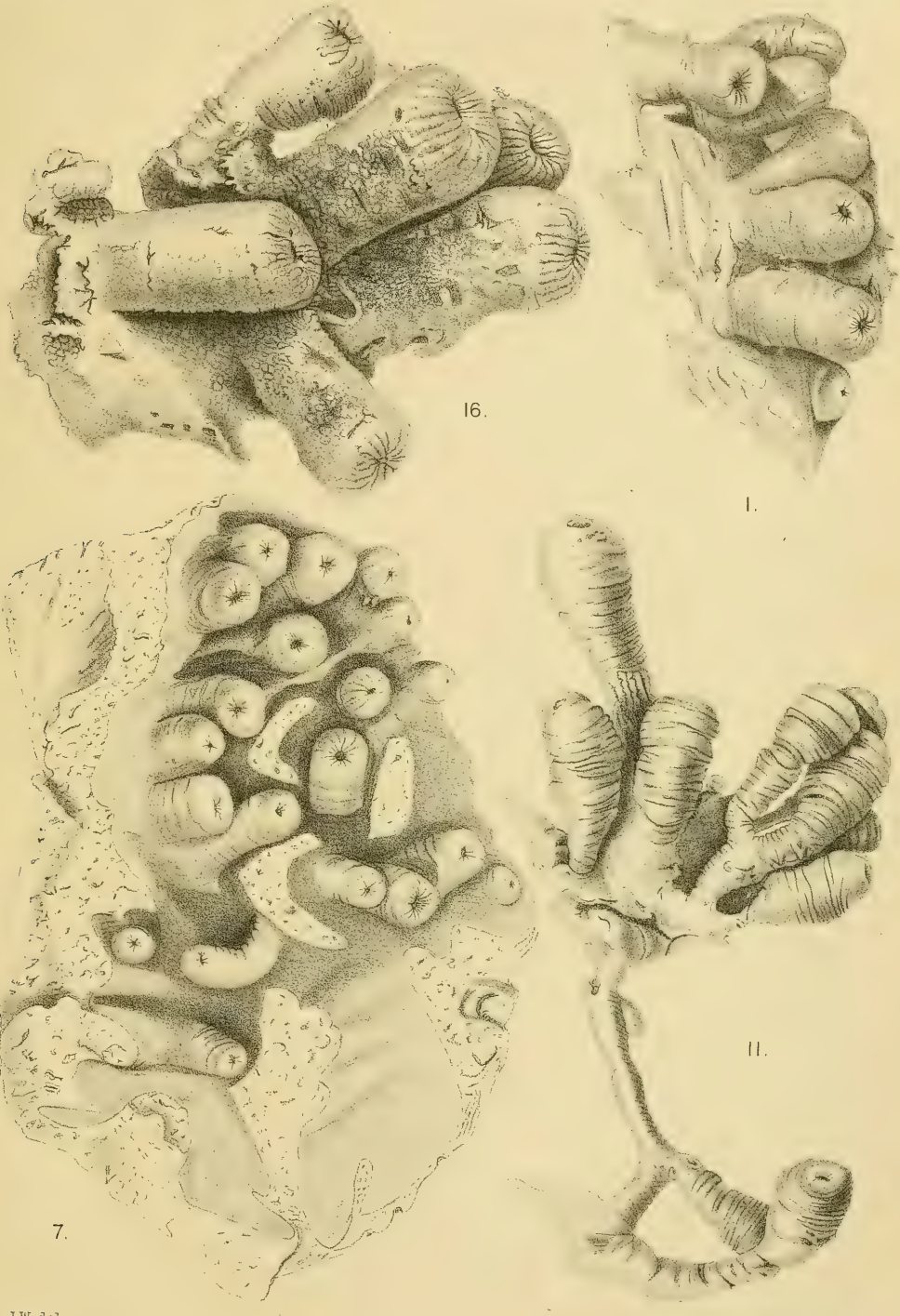
Fig. 2. *Zoanthus sandvicensis*. Transverse section through column-wall. × 282.
3. *Zoanthus sandvicensis*. Longitudinal section through the sphincter muscle. × 70.
4. *Zoanthus sandvicensis*. Longitudinal section through tentacle near tip. × 220. A small group of the refractive bodies at one end only drawn.
5. *Zoanthus sandvicensis*. Longitudinal section through disc. × 440.
6. *Zoanthus sandvicensis*. Transverse section through a perfect mesentery. × 188.
8. *Zoanthus similis*. Transverse section through column-wall. × 282.
9. *Zoanthus similis*. Longitudinal section through sphincter muscle. × 70.
10. *Zoanthus similis*. Transverse section through œsophageal region. × 34.

## Plate 45.

Fig. 12. *Zoanthus pigmentatus.* Longitudinal section through column-wall. × 282.
13. *Zoanthus pigmentatus.* Longitudinal section through sphincter muscle. × 52.
14. *Zoanthus pigmentatus.* Transverse section through œsophageal region. × 70.
15. *Zoanthus pigmentatus.* Transverse section through a perfect mesentery. × 188.
17. *Gemmaria arenacea.* Hand-cut section showing incrustations.
18. *Gemmaria arenacea.* Transverse section through œsophageal region, showing lacunæ left by decalcification. × 34.
19. *Gemmaria arenacea.* Longitudinal section through sphincter muscle. × 52.
20. *Gemmaria arenacea.* Longitudinal section through disc near centre. × 440.

### Lettering adopted in the Figures.

*bc.*, basal canal.
*cu.*, cuticle.
*d.*, diatoms.
*dist.sph.m.*, distal sphincter muscle.
*di.*, disc.
*d.m.*, directive mesenteries.
*sph.m.*, sphincter muscle.
*ect.*, ectoderm.
*ect.b.*, ectodermal bay.
*ect.c.*, ectodermal canal.
*ect.m.*, ectodermal muscle.
*end.*, endoderm.
*end.m.*, endodermal muscle.
*g.lac.*, globular lacunæ.
*inc.*, incrustation.
*lac.d.*, lacunæ caused by decalcification.
*l.m.*, longitudinal muscle.
*m.*, mesoglœa.
*n.c.*, nerve-cell.
*nem.*, nematocyst.
*oes.*, œsophagus.
*p.*, parasites.
*pb.m.*, parieto-basilar muscle.
*pig.*, pigment.
*prox.sph.m.*, proximal sphincter muscle.
*r.b.*, refractive bodies.
*s.d.*, sulcar directive.
*s.l.d.*, sulcular directives.
*spi.*, spicule.
*sp.*, spermaria.
*subc.*, subcuticle.
*sul.g.*, sulcar groove.
*t.*, tentacle.
*z.*, zooxanthellæ.

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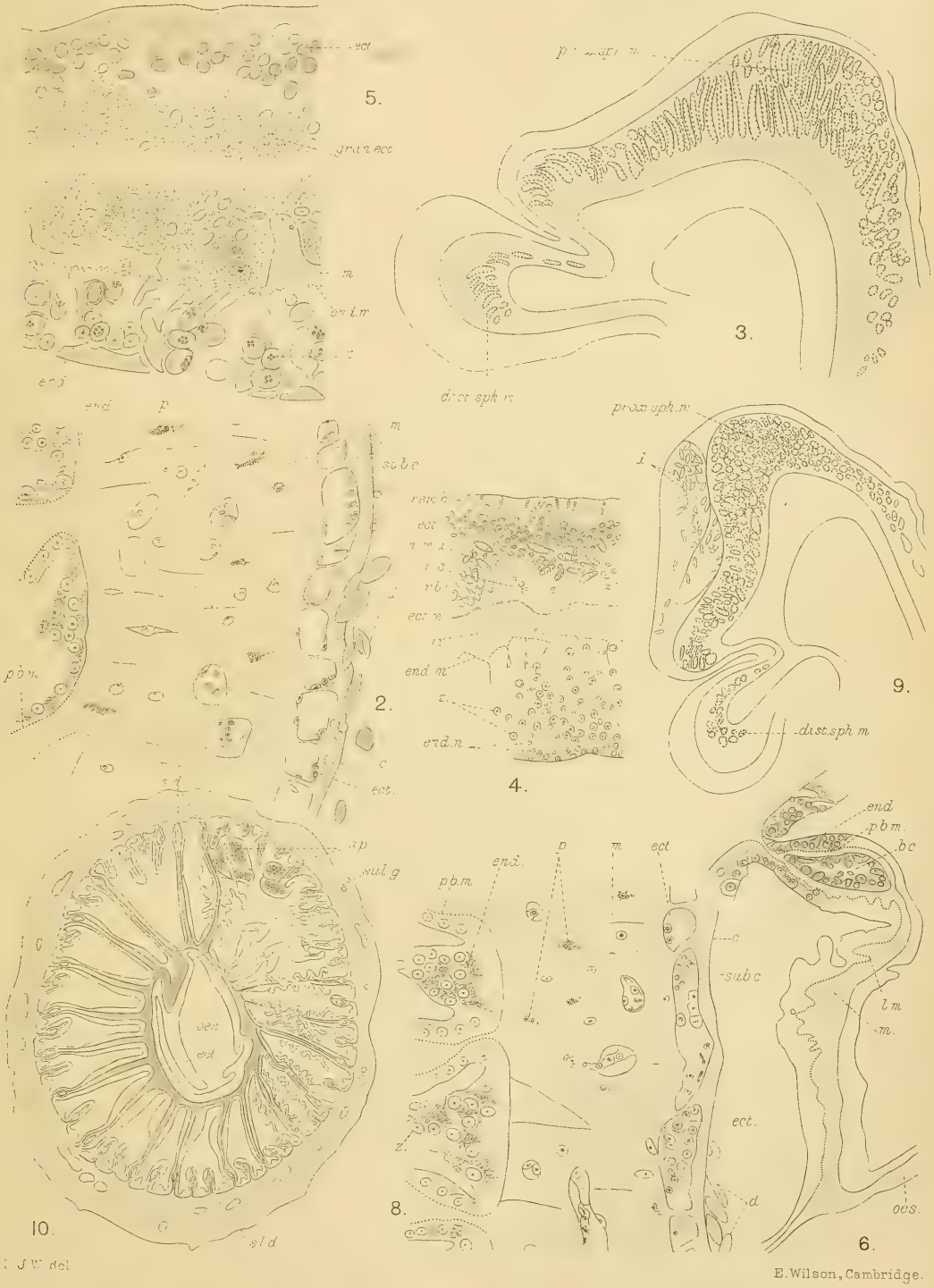


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ZOANTHEÆ FROM QUEENSLAND, ETC.


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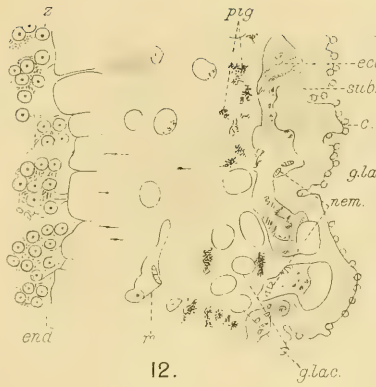


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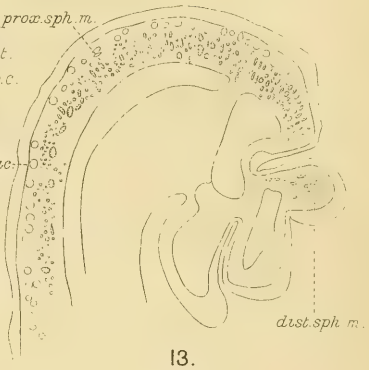


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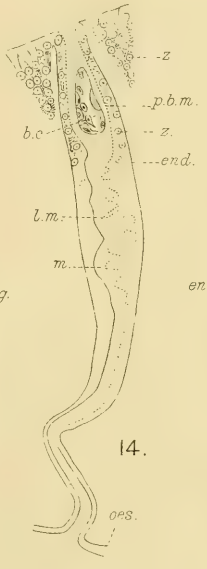


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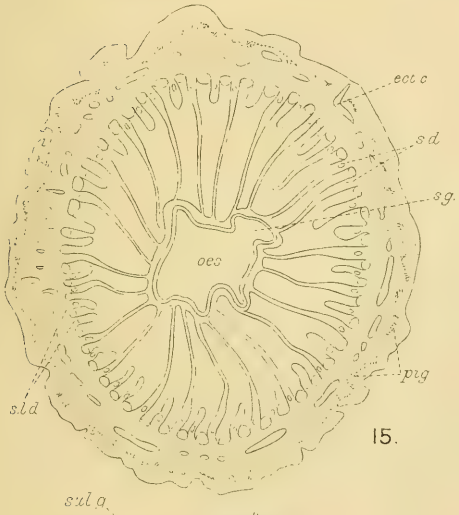


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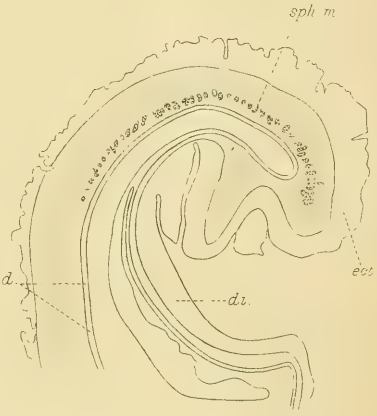


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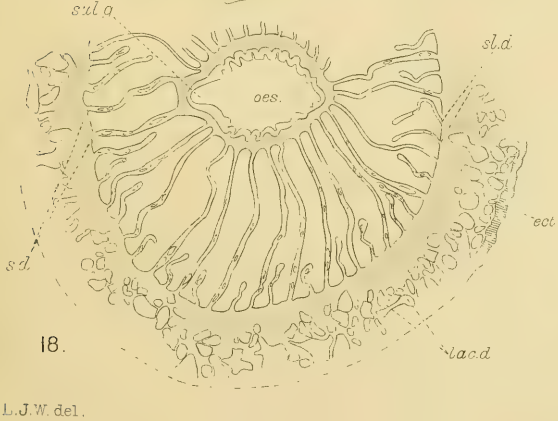


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